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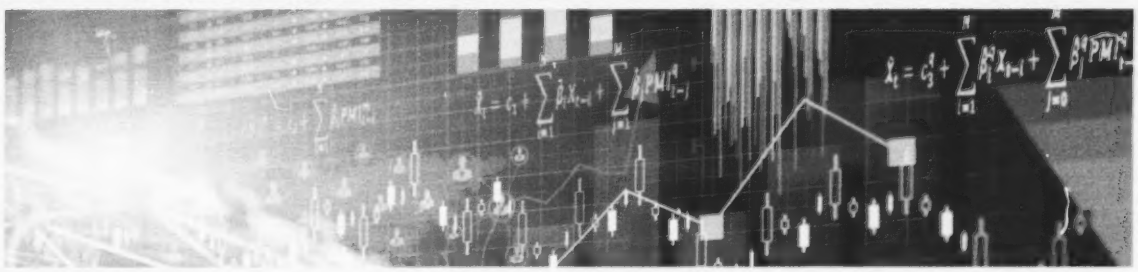
Prudential Liquidity Regulation in Banking—A Literature Review



by Adi Mordel

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Adi Mordel

Financial Stability Department
Bank of Canada
Ottawa, Ontario, Canada K1A 0G9
amordel@bankofcanada.ca

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Abstract

Prudential liquidity requirements are a relatively recent regulatory tool on the international front, introduced as part of the Basel III accord in the form of a liquidity coverage ratio (LCR) and a net stable funding ratio (NSFR). I first discuss the rationale for regulating bank liquidity by highlighting the market failures that it addresses while reviewing key theoretical contributions to the literature on the motivation for prudential liquidity regulation. I then introduce some of the empirical literature on the firm-specific and systemwide effects of that regulation. These findings suggest that while banks respond to binding requirements by increasing long-term funding and reducing maturity mismatch, there is also evidence that risk in the financial system has gone up. In an environment where both bank liquidity and capital are regulated, it is natural to consider the interactions between them. The main conclusions from this growing literature indicate that while liquidity requirements tend to make capital constraints less binding, capital requirements appear to be more costly to comply with, and that both regulations have a non-trivial effect on financial stability. I conclude with a discussion of potential avenues to explore as the Basel III liquidity standards are being implemented in Canada.

Bank topics: Financial institutions; Financial system regulation and policies
JEL codes: G, G2, G21, G28

Résumé

Les exigences en matière de liquidité prudentielle sont une mesure de réglementation relativement récente sur la scène internationale. Elles ont été introduites dans le cadre de l'accord de Bâle III sous forme de ratios de liquidité à court terme et à long terme. Dans le présent document, j'explique d'abord en quoi la réglementation de la liquidité bancaire se justifie. Je souligne ainsi les défaillances du marché qu'elle vise à corriger, tout en passant en revue les principaux apports théoriques à l'appui de la réglementation de la liquidité prudentielle. Je présente ensuite certaines études empiriques traitant des effets de ces règles sur les banques et sur l'ensemble du système. Il en ressort que, malgré le fait que les banques réagiraient aux exigences contraignantes en augmentant leur financement à long terme ainsi qu'en réduisant l'asymétrie des échéances, il y aurait tout de même eu une hausse des risques pesant sur le système financier. Dans un contexte où la liquidité et les fonds propres des banques sont réglementés, il convient de se pencher sur les interactions entre ces deux éléments. De plus en plus nombreuses, les études à ce sujet en viennent essentiellement aux conclusions suivantes : 1) les exigences de liquidité tendent à faciliter le respect des contraintes en matière de fonds propres, mais ces dernières semblent plus coûteuses à respecter; 2) ces deux formes de réglementation ont un effet non négligeable sur la stabilité financière. Je conclus sur les possibilités à explorer à l'occasion de la mise en œuvre des normes de liquidité de Bâle III au Canada.

Sujets : Institutions financières; Réglementation et politiques relatives au système financier
Codes JEL : G, G2, G21, G28

On the rationale for, and the design of, liquidity regulation

I start by reviewing some of the key theoretical contributions to the literature on the need for and the design of liquidity regulation. Earlier contributions on the market failures that justify liquidity regulation are provided by Rochet (2004, 2008). A formal model of liquidity regulation is developed by Perotti and Suarez (2011), while in Calomiris, Heider and Hoerova (2015), the emphasis is on the supplementary effect of liquidity regulation to capital regulation. Diamond and Kashyap (2016) justify the Basel-III-type liquidity regulations since asymmetric information between depositors and banks leads the latter to hold insufficient liquidity. In Stein (2013), liquidity regulation is advantageous to a lender of last resort (LoLR) since an LoLR potentially induces moral hazard. Finally, Allen and Gale (2016) highlight the importance of accounting for incentives to innovate around liquidity regulation.

Rochet (2008) describes the market failures that explain why bank liquidity should be regulated. At its core, the opaqueness of bank assets generates moral hazard in the form of insufficient effort in screening borrowers and monitoring their activities after a loan has been granted. But when a liquidity need arises, as when borrowers require additional funding or depositors withdraw unexpectedly, the corporate finance literature concludes that under these conditions financial markets will not provide sufficient liquidity (Tirole 2006). Earlier work by Rochet (2004) points out that this type of a market failure can be addressed via contractual arrangements in the form of liquidity pools and interbank credit line commitments.

Rochet also emphasizes that asset opaqueness creates an externality between lenders. It arises when the decision to renew funding depends not only on fundamental uncertainty (i.e., on the quality of the bank's assets) but also on strategic uncertainty. This coordination failure is present when large uninsured depositors withdraw funding because they anticipate others will do the same. Liquidity requirements would then mitigate the impact of strategic uncertainty since the bank could withstand larger withdrawals. This phenomenon of dual uncertainty is addressed by global games models, which I review later. Finally, Rochet highlights the market failure that arises from banks' anticipation of government intervention in case of a macroeconomic shock, as banks may take excessive exposures to benefit from bailouts in case of risk materialization. He concludes that liquidity regulation may mitigate this behaviour.

Addressing these market failures broadly takes two forms: either via liquidity regulation or via a central bank acting as an LoLR that lends against the illiquid assets of an otherwise solvent bank. While much of the earlier literature identifies this channel as the main method for dealing with run-like liquidity problems, Stein (2013) argues that liquidity regulation is a more favourable solution since using an LoLR is socially costly.[1] Given that, when under stress, the difference

[1] In Stein (2013), banks add social value by being liquidity providers, but this generates run risk, which carries significant negative spillovers to the system. This externality creates a motivation for a policy intervention.

between illiquidity and insolvency is blurry, an LoLR is likely to take on credit risk, which ultimately exposes taxpayers. Furthermore, an LoLR induces moral hazard problems by encouraging banks to be less prudent *ex ante*. Hence liquidity regulation serves to deter reliance on an LoLR and, under stressful conditions, buys time for authorities to assess liquidity needs and to arrange an appropriate lending facility, a point that is explicitly mentioned in the liquidity coverage ratio (LCR) rules (see also Carlson, Duygan-Bump and Nelson 2015).

If liquidity regulation is warranted, a natural question that arises is why would banks not hold large liquidity buffers voluntarily? According to Stein (2013), banks keep insufficient liquidity because otherwise they bear all the costs of holding liquid assets without capturing all the associated social benefits, such as enhanced financial stability and lower costs to taxpayers in the event of failure. In Diamond and Kashyap (2016), imperfect information is the source of underinvestment in liquid assets. Specifically, because depositors cannot ascertain whether the bank is holding sufficient liquidity, the bank has reduced incentive to hold liquid assets since it prefers to make more profits from lending, exposing itself to runs. The need for liquidity regulation arises under either rationale.

Liquidity regulation can take different forms. Perotti and Suarez (2011) model price and quantity-based measures to regulate the systemic externalities associated with overreliance on short-term funding. The response of banks to the regulation depends on the composition of their characteristics. Specifically, if banks differ in their capacity to lend profitably (i.e., the return on lending is heterogeneously distributed), then the preferred solution is a Pigouvian tax that equates the private benefit to the bank of short-term funding with its social cost.[2] But if banks differ along their gambling incentives, as captured via different capital levels or charter values, then quantity constraints (as net funding ratios) are more efficient.[3] In general, though, since banks differ along multiple dimensions, an optimal policy should involve both types of tools. In Walther (2016), efficiency is achieved through a simple linear constraint on banks' balance sheets—such as the LCR or net stable funding ratio (NSFR)—which requires less information than central planning or Pigouvian taxation. In Calomiris, Heider and Hoerova (2015), the regulation focuses on the banks' asset side in the form of cash reserve requirements or deposits held at the central bank. In their framework, the primary benefit from cash relates to its special role in motivating proper risk management, making the banking system more resilient and thereby lowering the probability of crisis.[4]

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[2] The intuition is that liquidity risk levies allow better banks to lend more, without requiring the regulators to identify them. In this context, quantity-based instruments such as the NSFR or the LCR are generally distortionary since they depend on individual bank characteristics, most of which are imprecisely measured or are unobservable.

[3] Levies are not as effective because riskier banks will be more inclined to pay the tax and expand their lending. In this case, quantity tools such as net funding or capital ratios are best to contain excess credit expansion.

[4] This framework resolves Goodhart's paradox; Goodhart (2008) argues that because cash requirements force banks to hold cash, they may limit its usefulness in resolving liquidity problems. In Calomiris, Heider and Hoerova (2015), the incentive benefits of holding cash enable markets to function better, and their usefulness does not depend on a bank's ability to resolve liquidity risk via a cash payout.

Finally, the design of liquidity regulation should consider incentives to innovate around it. Allen and Gale (2016) model how funding can be engineered such that it allows the bank to appear as if it meets the liquidity requirement but still leaves the bank exposed to runs, and so the regulation does little to instill financial stability.[5]

Empirical evidence on the effect of liquidity regulation

While the LCR's objective is to promote the short-term resilience of a bank's liquidity risk profile,[6] regulation targeted at the individual institution may have system-wide implications. This section suggests that this is a potential outcome that warrants closer examination over time. I proceed by first presenting the literature's evidence from jurisdictions that enacted microprudential liquidity regulation before Basel III. Results indicate that under binding regulatory liquidity conditions, banks respond by raising demand for long-term funding. I then present some LCR-based evidence to indicate that while this measure lowered maturity mismatch, it may also have raised risks in the financial system.

Prudential liquidity regulation is a recent concept with limited empirical evidence on its effectiveness. The reason is that in most jurisdictions, before the implementation of Basel III, prudential liquidity requirements were not used. A notable exception is the Dutch liquidity ratio, introduced in 2003 (DNB 2003), and the UK's 2010 implementation of heterogeneous liquidity standards. Both measures are akin to the LCR, since they require banks to hold high-quality liquid assets (HQLA) against cash outflows. I follow two resources, Bonner and Eijffinger (2016), who study the impact on Dutch banks, and Banerjee and Hio (2017), who document the UK experience.

Liquidity regulation affects banks' balance sheets. Specifically, Dutch banks hold liquidity buffers above the minimum requirement, which are determined by a bank's size, capitalization and profitability.[7] Furthermore, evidence from the Dutch interbank market suggests that liquidity requirements motivate banks to borrow at longer terms but issue fewer long-term loans, consistent with the theoretical rationale for liquidity regulation. Adjustments on both sides of the balance sheet are also presented for UK banks. On the liability side, banks seem to increase funding from

[5] The model is motivated by Alloway (2015), who shows that upon the introduction of the LCR in the United States, there was a surge in the issuance of extendable repos. In this form of evergreen funding, the liabilities are not counted as short-term obligations since they are continually renewed with a notice period that is greater than 30 days, the cut-off specified under the LCR regulation. Depending on the length of the notice period extension beyond 30 days, this might not alter systemic risk significantly.

[6] See Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools.

[7] De Haan and Van den End (2013) also show that Dutch banks operate with liquidity margins above their mandatory requirements. Duijm and Wierts (2016) use an error-correction model and find that in response to a liquidity shock, Dutch banks mainly adjusted their liability side, moving away from high-runoff-rate wholesale funding into more stable deposits. Bonner (2016) finds that microprudential liquidity requirements increase banks' demand for government bonds at the expense of other bonds.

stable sources, such as domestic deposits by non-financial entities, and reduce dependence on less-stable short-term wholesale funding and non-resident deposits.

To date, there is no conclusive evidence that liquidity regulation affects the cost of lending. Under binding liquidity constraints, Dutch banks have not passed the higher funding costs to their clients, since there have been no changes in the lending rate to the real economy, although this depends on the level of aggregate liquidity. Essentially, constrained banks face tighter interest margins, a point that central banks should consider when implementing monetary policy. The limited interest rate impact is also documented for UK banks, suggesting that tougher liquidity regulation affects bank profitability primarily through the substitution toward lower-yielding HQLA and more expensive non-financial deposit funding.

Evidence from the United States, where the LCR has been in effect since 2015, suggest that while the banking sector indeed reduced its liquidity mismatch and run risk, as envisaged by the regulation, intermediaries also became riskier and potentially less diversified.

Sarkar, Shachar and Roberts (2018) investigate the trade-off between liquidity creation (through the transformation of illiquid loans into liquid deposits) and liquidity resiliency for the banking system. They compare LCR and non-LCR banks, since the regulatory requirement depends on bank size. They find lower liquidity mismatch for compliant banks (implying lower liquidity creation) that is not offset by increased liquidity creation of non-LCR banks. Thus, overall liquidity creation of the banking sector decreased, which is consistent with the LCR's objective.

But there are broader implications of the LCR that affect other non-bank intermediaries. One example is in Gete and Reher (2017), who show that since the LCR regulation applies a less favourable treatment to government-sponsored enterprise mortgage-backed securities (MBS) (that face a 15 per cent haircut) compared with Government National Mortgage Association (GNMA) MBS (that face no haircut), this induces stronger demand for GNMA MBS. This increased demand in turn raises their price and encourages more mortgage securitization (and home ownership), especially by non-banks who cater to riskier borrowers.

Li (2018) looks at relationship lending between banks and money market mutual funds (MMMFs), where both types of financial intermediaries face competing liquidity requirements: MMMFs are pushed to invest in shorter maturities, while banks are required to borrow long term.[8] The author shows that the two intermediaries develop a symbiotic relationship where banks accommodate MMMFs' demand for short-term instruments (i.e., overnight euro deposits), while MMMFs reciprocate by providing longer-term funding for banks (one-year certificates of deposit). According to the author, the concern is that such a relationship makes the financial system more

[8] The 2010 Securities and Exchange Commission reforms discourage MMMFs from investing in long-term debt, motivating them to engage in more overnight lending. Basel III, on the other hand, is promoting bank reliance on stable long-term funding as opposed to short-term borrowing.

fragile and less diversified, as investment decisions across multiple markets are made collectively in a reciprocal manner.

The interaction between prudential liquidity and capital requirements

The recent financial crisis made it clear that bank liquidity and solvency problems are intertwined. Therefore, it is only natural to consider the design, coordination and implication of these regulations in tandem. In their most basic forms, capital requirements directly limit the fraction of bank loans that can be financed via deposits, while liquidity requirements force banks to hold safe assets against deposits, limiting liquidity transformation and thereby restricting the asset side of the balance sheet.

There is a growing literature on the interaction between prudential liquidity and capital requirements, with mixed evidence on their economic implications. Liquidity requirements tend to make capital less binding, and while some economists conclude that capital requirements are more costly, both regulations have a non-trivial effect on financial stability. For example, in Roger and Vlček (2011), banks must hold a share of their assets in liquid government securities. This is costly because liquid assets offer lower yields, thereby leading to smaller revenues. The authors emphasize the complementary role of capital and liquidity regulation, since raising bank liquidity also raises capital adequacy. In Boissay and Collard (2016), a social planner sets time-invariant capital and liquidity requirements to maximize social welfare, and liquidity requirements are costly as they reduce investment in risky assets. The two regulations reinforce each other because an increase in the share of liquid assets reduces the volume of risky assets per unit of equity, enhancing the disciplinary effect of equity.

Using a global game model, Vives (2014) studies the efficient combination of equity capital and liquidity holdings that would make banks safer by deterring runs. The effectiveness of either policy depends on the extent to which depositors are conservative. If depositors are inclined to run, then increased liquidity holdings enhance financial stability, and this is beneficial even as it reduces bank profits (since the bank invests more in low-yield liquid assets). This last point is emphasized by König (2015), who argues that more bank liquidity can hurt a bank's solvency position in the long run and therefore be counterproductive. According to that paper, liquidity regulation has two opposing effects: the liquidity buffer mitigates illiquidity risk, but it also raises insolvency risk due to lower returns. Hence liquidity regulation is effective in reducing a bank's overall default risk only if the former effect dominates the latter.

Some papers focus on the use of both policies under the externality of fire sales. In Kara and Ozsoy (2016), when capital is the only regulatory tool, banks respond by decreasing liquidity ratios further below the already inefficient levels in the competitive equilibrium. In other words, by limiting investment in risky assets and improving financial stability, capital regulation reduces banks' incentives to hold liquid assets. The regulator in turn tightens capital requirements further, leading to inefficiently higher levels of capital and lower socially profitable long-term investments.

Augmenting capital with liquidity regulation allows banks to hold more risky assets without increasing fire sale risk, thereby improving financial stability (i.e., fire sales are less severe while asset prices are higher in the bad state).

Van den Heuvel (2016) quantifies the welfare costs of capital and liquidity regulations. While both regulations mitigate bank moral hazard (excessive credit and insufficient liquidity holding), they are costly because they reduce the ability of banks to create net liquidity through the transformation of illiquid loans into liquid deposits. The paper concludes that liquidity requirements are costly if high-quality liquid assets are in limited supply and have important alternative uses. When compared with capital requirements, liquidity requirements entail lower social costs (measured in terms of foregone consumption), but their financial stability benefits are also narrower. The reason is that capital requirements address both sources of moral hazard, i.e., excessive extension of risky loans and exposure to liquidity stress, while liquidity requirements address only the latter.

Adrian and Boyarchenko (2017), on the other hand, show that liquidity requirements are preferable to capital requirements, since tightening the former lowers the likelihood of systemic distress without impairing consumption growth. Ahnert (2016), who models rollover risk in the context of a global game, also concludes that, with regards to fire sales, liquidity regulation is preferable since it reduces liquidation by one intermediary and increases the liquidation value of the other.

Miller and Sowerbutts (2018) formally model the interaction between liquidity regulation and banks' funding costs to provide evidence of an overlooked benefit. They model runs where solvent banks may fail due to illiquidity by endogenizing a firm's funding costs and solving for its optimal choice of liquidity. While forcing the bank to hold more liquidity affects its profitability, it also allows the bank to pay less for its funding, thereby offsetting some of the cost of complying with the regulation. Interestingly, though, the effect depends on the level of the bank's capital—i.e., there is a capital ratio threshold below which that benefit does not accrue to the bank.

Empirical evidence on the interaction between the two regulations is scarce. Earlier analysis includes De Haan and Van den End (2013), who show that more-solvent Dutch banks hold fewer liquid assets against their stock of liquid liabilities, but that this interaction is weaker during a crisis. More recently, Bruno, Onali and Schaeck (2018) conduct an event-study on European bank stock price reactions to the Bank for International Settlements (BIS) liquidity regulation announcements between 2010 and 2015. The authors find weak evidence to suggest that liquidity regulation is binding, since, on average, stock prices did not respond to specific news on liquidity regulation, but rather only when it was combined with news on capital regulation. These results indicate that although liquidity regulation is likely to gradually become an important tool of the regulatory framework, capital regulation currently remains the dominant component, both in terms of what is considered by markets to be binding and in terms of value relevance.

Conclusion

The intermediation process between savers and borrowers involves maturity transformation that could expose banks to liquidity risk. This became evident during the 2008–09 financial crisis and prompted the introduction of a liquidity framework as part of Basel III, which Gomes and Wilkins (2013) discuss in detail. Following the policy development and implementation phase, it is now possible to assess the implication of prudential liquidity regulation. This paper reviews the recent academic evidence on this topic and summarizes its key findings. Overall, the literature to date concludes that banks respond to a binding liquidity constraint by raising long-term funding; that under normal economic conditions, banks are less likely to pass on to borrowers the higher costs of complying with such regulation (costs that appear to be lower than those related to capital requirements); and that while the regulation lowers maturity mismatch, it may also increase risk in the financial system.

There is value in studying whether some of these effects are present in Canada, given that the LCR has been in effect since 2015 (the NSFR's implementation date is January 2020). As a starting point, one can measure the level of liquidity mismatch in the Canadian banking system, and document how it evolves with the LCR implementation, by following Bai, Krishnamurthy and Weymuller (2018), who construct a liquidity mismatch index (LMI) to gauge the difference between the market liquidity of assets and the funding liquidity of liabilities. The authors show that the LMI is informative about both individual bank liquidity and the liquidity risk of the entire banking system. A key benefit of the LMI is that it accounts for the time-varying state of liquidity conditions, but the measure is data intensive since it requires repo haircut data on various securities that banks hold.

A promising avenue to explore is to identify the extent to which the LCR and the upcoming NSFR would affect the domestic market for bankers' acceptances (BA), a primary funding source for small and mid-sized corporations. McRae and Auger (2018) review that market and present anecdotal evidence on how banks, through their investment dealers, actively manage their BA inventories, suggesting that the domestic banking system is potentially adjusting to this regulation with pricing implications that are already evident.[9] If borrower-lender BA relations differed along multiple dimensions, the effect of the added liquidity compliance cost could depend on the borrower and lender characteristics, thereby influencing the ability to pass on those higher costs to borrowers. This represents a direct effect of liquidity regulation on the real economy, a channel that is worth exploring.

Another possibility is to consider the effect on retail deposits. Recall that the LCR and NSFR treat retail deposits as a more stable funding source, which may be captured in their pricing. An interesting application would be to estimate this regulatory premium, which could also have

[9] Implications of this behaviour could affect the reliability of the Canadian Dollar Offered Rate, which is derived from BA transactions and represents a benchmark for various interest rate contracts.

competitive consequences as banks price deposits while taking into account their regulatory positions. Finally, it is worth mentioning that Canada is one of the few countries where liquidity regulation was in effect before Basel III. Since 2008, the Office of the Superintendent of Financial Institutions has implemented the net cumulative cash flow (NCCF), which is a metric of the liquidity survival horizon. The measure, which was first introduced to the largest banks (the Big Six), features a minimum required survival horizon, which was tightened a couple of times. The NCCF was later introduced selectively to a few smaller federally regulated financial institutions.[10] The aspects described here represent a few dimensions that could be leveraged to help identify the effect of liquidity regulation within the Canadian context.

References

Adrian, T. and N. Boyarchenko. 2017. "Liquidity Policies and Systemic Risk." *Journal of Financial Intermediation.*

Ahnert, T. 2016. "Rollover Risk, Liquidity and Macroprudential Regulation." *Journal of Money, Credit and Banking* 48 (8): 1753–1785.

Allen, F. and D. Gale. 2016. "Liquidity Regulation, Extended Repo and the Real Economy." Working Paper, Imperial College London.

Alloway, T. 2015. "This Chart Shows the Incredible Increase in Extendable Repos." Bloomberg Markets, December 8.

Bai, J., A. Krishnamurthy and C.-H. Weymuller. 2018. "Measuring Liquidity Mismatch in the Banking Sector." *The Journal of Finance* 73 (1): 51–93.

Banerjee, R. and M. Hio. 2017. "The Impact of Liquidity Regulation on Banks." *Journal of Financial Intermediation.*

Boissay, F. and F. Collard. 2016. "Macroeconomics of Bank Capital and Liquidity Regulations." BIS Working Paper No. 596.

Bonner, C. 2016. "Preferential Regulatory Treatment and Banks' Demand for Government Bonds." *Journal of Money, Credit and Banking* 48 (6): 1195–1221.

Bonner, C. and S. C. W. Eijffinger. 2016. "The Impact of Liquidity Regulation on Bank Intermediation." *Review of Finance* 20 (5): 1945–1979.

Bruno, B., F. Ongali and K. Schaeck. 2018. "Market Reaction to Bank Liquidity Regulation." *Journal of Financial and Quantitative Analysis* 53 (2): 899–935.

Calomiris, C., F. Heider and M. Hoerova. 2015. "A Theory of Bank Liquidity Requirements." Columbia Business School Research Paper No. 14-39.

Carlson, M., B. Duygan-Bump and W. Nelson. 2015. "Why Do We Need Both Liquidity Regulations and a Lender of Last Resort? A Perspective from Federal Reserve Lending during the 2007–09 US Financial Crisis." Finance and Economics Discussion Series 2015-011. Washington: Board of Governors of the Federal Reserve System.

De Haan, L. and J. van den End. 2013. "Bank Liquidity, the Maturity Ladder, and Regulation." *Journal of Banking & Finance* 37 (10): 3930–3950.

De Nederlandsche Bank (DNB). 2003. *Regulation on Liquidity under the Wft.* Amsterdam.

Diamond, D. W. and A. K. Kashyap. 2016. "Liquidity Requirements, Liquidity Choice and Financial Stability." *Handbook of Macroeconomics* 2: 2263–2303.

Duijm, P. and P. Wierts. 2016. "The Effects of Liquidity Regulation on Bank Assets and Liabilities." *International Journal of Central Banking* (June): 385–411.

[10] See comment by RBC and the IMF's NCCF discussion as part of the 2013 Financial Sector Assessment Program.

Gete, P. and M. Reher. 2017. "Nonbanks and Lending Standards in Mortgage Markets. The Spillovers from Liquidity Regulation." Working paper.

Gomes, T. and C. Wilkins. 2013. "The Basel III Liquidity Standards: An Update." Bank of Canada *Financial System Review* (June): 37–43.

Goodhart, C. 2008. "Liquidity Risk Management." Banque de France *Financial Stability Review – Special Issue on Liquidity* 11 (February): 39–44.

Kara, G. I. and S. M. Ozsoy. 2016. "Bank Regulation Under Fire Sale Externalities." Finance and Economics Discussion Series 2016-026. Washington: Board of Governors of the Federal Reserve System.

König, P. J. 2015. "Liquidity Requirements: A Double-Edged Sword." *International Journal of Central Banking* (December): 129–168.

Li, Y. 2018. "Reciprocal Lending Relationships in Shadow Banking." Working paper.

McRae, K. and D. Auger. 2018. "A Primer on the Canadian Bankers' Acceptance Market." Bank of Canada Staff Discussion Paper No. 2018-6.

Miller, S. and R. Sowerbutts. 2018. "Bank Liquidity and the Cost of Debt." Bank of England Staff Working Paper No. 707.

Perotti, E. and J. Suarez. 2011. "A Pigovian Approach to Liquidity Regulation." *International Journal of Central Banking* 7 (4): 3–41.

Roberts, D., A. Sarkar and O. Shachar. 2018. "Bank Liquidity Provision and Basel Liquidity Regulations." Federal Reserve Bank of New York Staff Report No. 852.

Rochet, J.-C. 2004. "Macroeconomic Shocks and Banking Supervision." *Journal of Financial Stability* 1 (1): 93–110.

———. 2008. "Liquidity Regulation and the Lender of Last Resort." Banque de France *Financial Stability Review – Special Issue on Liquidity* 11 (February): 45–52.

Roger, S. and J. Vlček. 2011. "Macroeconomic Costs of Higher Bank Capital and Liquidity Requirements." IMF Working Paper 11/103.

Stein, J. 2013. "Liquidity Regulation and Central Banking." Speech at the "Finding the Right Balance" 2013 Credit Markets Symposium sponsored by the Federal Reserve Bank of Richmond, Charlotte, NC, April 19.

Tirole, J. 2006. *The Theory of Corporate Finance*. Princeton: Princeton University Press.

Van den Heuvel, S. J. 2016. "The Welfare Effects of Bank Liquidity and Capital Requirements." Working paper.

Vives, X. 2014. "Strategic Complementarity, Fragility, and Regulation." *The Review of Financial Studies* 27 (12): 3547–3592.

Walther, A. 2016. "Jointly Optimal Regulation of Bank Capital and Liquidity." *Journal of Money, Credit and Banking* 48 (2–3): 415–448.